Fisheries and Oceans Canada | Pêches et Océans Canada

Canadian Stock Assessment Secretariat
Research Document 99/62

Not to be cited without
permission of the authors[1]

Secrétariat canadien pour l'évaluation des stocks
Document de recherche 99/62

Ne pas citer sans
autorisation des auteurs[1]

Assessment of the scallop stock in scallop production Area 1, Bay of Fundy for 1998

D. Roddick, M. Lundy, M. Butler, and S.J. Smith

Invertebrate Fisheries Division
Science Branch
Department of Fisheries and Oceans
P.O. Box 1006
Dartmouth, Nova Scotia

[1] This series documents the scientific basis for the evaluation of fisheries resources in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the Secretariat.

[1] La présente série documente les bases scientifiques des évaluations des ressources halieutiques du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Les documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au secrétariat.

ISSN 1480-4883
Ottawa, 1999

Canada

Abstract

Starting on 1 January 1997, the Bay of Fundy scallop fishery was divided into Scallop Production Areas (SPA's) for management considerations. This move was made in response to declining catches and concerns over the long term viability of the scallop fishery. SPA 1 is the largest SPA in the Bay of Fundy and is accessible, at least in part, to all bay of Fundy scallop license holders. This assessment examines previous and current survey data, logbook data, and the Full Bay fleet port sampling data. Some of the data is preliminary as work is being done to incorporate the new management boundaries into the databases.

Survey biomass estimates and commercial catch rates have declined from the historic peak in 1988/89, to the lowest levels in either time series. At the present level of effort the removals from the stock in the traditional Digby and Cape Spencer areas appear to be balanced by growth and a low level of recruitment. The population of large scallops is being fished down and there are no signs of a strong recruitment pulse in the next few years. The outlook is for a stable but low scallop abundance in this area, as long as fishing effort remains at present levels.

Résumé

Depuis le 1er janvier 1997, la pêche du pétoncle de la baie de Fundy est régie au moyen de zones de production du pétoncle (ZPP) afin d'en faciliter la gestion. Cette mesure a été prise en réaction à la baisse des captures et aux inquiétudes relatives à la viabilité à long terme de cette pêche. La ZPP 1 est la plus importante de la baie de Fundy et peut être utilisée, du moins en partie, par tous les détenteurs de permis de pêche du pétoncle de la baie de Fundy. La présente évaluation porte sur les données, tant actuelles qu'antérieures des relevés, des registres de bord et des échantillonnages aux ports réalisés pour la flotte de la catégorie "Full Bay". Certaines des données sont provisoires car les travaux visant à inclure les nouvelles limites des zones de gestion aux bases de données ne sont pas encore terminés.

Les estimations de biomasse obtenues par relevés et les taux de capture commerciaux ont diminué pour passer du maximum historique en 1988-1989 aux plus faibles valeurs des deux séries chronologiques. Au niveau d'effort de pêche actuel, les prélèvements faits au stock dans les zones de pêche traditionnelles de Digby et de Cape Spencer semblent être équilibrés par la croissance et un faible recrutement. La population de pétoncles de grande taille est actuellement récoltée et rien n'indique l'arrivée d'une importante vague de recrutement au cours des prochaines années. On peut s'attendre, si l'effort de pêche demeure constant, à un niveau d'abondance du pétoncle stable mais faible dans cette région.

Introduction

Commercial scallop fishing in the Bay of Fundy was first reported by W.F. Ganong in 1889 (Ganong 1889), who reported that about 200 bushels originating from Maces Bay and L'Etang Harbour were sold annually in Saint John. In the 1920's, a commercial fishery started in Annapolis Basin N.S., where scallops had first been reported by Lescarbot in 1609. This fishery quickly moved out into the productive grounds off Digby, Nova Scotia. Scallop fishing regulations were first initiated in 1918 with licenses, a minimum size and closed seasons. These types of regulations are still in use for this fishery. Special regulations for specific areas within the Bay of Fundy date back to 1939 when a restriction on gear width was introduced specifically for Grand Manan waters. On the Nova Scotia side, a special zone was created off Digby in 1952, with a closed season from May 1 to September 30 to provide an area close to port for the winter fishery.

With declining catches and concerns over the long term viability of the fishery, the Bay of Fundy was divided into Scallop Production Areas (SPA's) for better management (Figure 1). These SPA's came into effect on January 1, 1997.

Scallop production Area 1 in the Bay of Fundy is a large area comprising several different fishing areas, and is accessible by three different scallop license categories (Table 1). Full Bay scallop licenses are able to fish scallops anywhere in the Bay of Fundy and are usually held by larger (>25.5 Gross Tons (G.T.)) vessels. Mid Bay license holders can fish for scallops on the northern side of the Mid Bay line (Figure 1), and Upper Bay license holders east of the Upper Bay line. These last two categories are typically held by smaller multi-purpose vessels that fish local waters. Landings for Area 1 increased from 1997, and in 1998 were 187.9 t for the Full Bay vessels, 31.1 t for the Mid Bay vessels and 12.1 t for the Upper Bay vessels. This is a 78% increase in landings over 1997.

Scallops are found in varying densities throughout most of Area 1, but the main concentrations are found on the Nova Scotia side outside Area 4, from Sandy Cove to Hampton (Figure 1), and out past the Mid Bay Line towards Cape Spencer New Brunswick. The productive area on the Nova Scotia side of the Mid Bay line is accessible only to the Full Bay

License holders. The Cape Spencer bed, from the Mid Bay line extending towards Cape Spencer on the New Brunswick side, has been the second most productive area in recent times.

With the switch to Scallop Production Areas, and the recent requirement for the Mid Bay license holders to submit logs, there has been considerable effort required in revising existing databases and setting up some new ones. This is ongoing and the data is still being edited, as a result, the numbers presented here will often not be an exact fit with the Area 1 boundaries, and should all be considered preliminary. For this analysis two sections of Area 1 will be examined: the "2-16 mile" section from Sandy Cove to Hampton, excluding Area 4; and the section from 16 miles going towards Cape Spencer, New Brunswick.

Data Availability:

Research surveys

There have been annual surveys of the Digby portion of Area 1 since 1978 (Kenchington et al. 1995). The Cape Spencer grounds were first surveyed in 1987, (Chandler et al. 1989) during a survey of the Northern side and Upper Bay area. Robinson and Chandler (1990) and Robinson *et al.* (1992) conducted surveys covering the Cape Spencer area in 1989, 1990 and 1991. Grid surveys of the Cape Spencer area were conducted in 1996 and 1997, in conjunction with the stratified random surveys of the 2-16 mile Digby area, and the design was changed to a random survey in 1998. The Upper Bay area was surveyed in 1987 (Chandler et al., 1989) and in conjunction with studies on the effects of opening the Peticodiac River causeway in 1998 (Kenchington et al., 1998) and 1999. The Upper Bay Surveys are not covered here.

Logbooks

Logbooks were required for vessels >25 gross tonnes (G.T.) starting in 1973. In 1979 the requirement was changed to vessels > 25.5 G.T. or > 14 m Length Over All (LOA). These requirements cover most of the Full Bay license holders but few of the Mid Bay or Upper Bay licenses, although some of these vessels have submitted logbooks. The Mid Bay and Upper Bay license holders agreed to complete logbooks on a voluntary basis in 1996 and logbooks became mandatory in 1997. The Mid and Upper Bay logbook data is still being edited, and so the results

presented here should be considered preliminary. In the Full Bay Fleet, the percentage of active licenses that submitted logs has varied from 14 to 100% (Table 1).

Port sampling

Port samples were collected regularly from the Full Bay Fleet landing in Nova Scotia, but there has been no port sampling coverage of the Mid Bay or Upper Bay Fleets in Area 1. Most of the available Full Bay samples comes from the 2-16 mile Digby Area.

Methods

The survey analysis was divided into two separate areas. The first was the area 2-16 miles off the Nova Scotia shore from Sandy Cove to Hampton, for which a time series of surveys exists. Annual surveys of this area have been conducted since 1978, but the station allocation scheme and area covered has changed during this period. For a full description of these changes see Kenchington et al. (1995). For this reason, the 1991 to 1997 surveys, which are of a consistent area and with the most consistent design, will be the main ones used for this analysis, with the older surveys used to look at longer term trends. The survey area is now split between Scallop Production Area (SPA) 1 and SPA 4, which extends out to 8 miles from Sandy Cove to Parkers Cove (Figure 1). The Area 1 survey is therefore broken down into two sections, the 8-16 mile area from Sandy Cove to Hampton, and a 2-8 mile area above Area 4 (Figure 2).

Tows of approximately 8 minutes duration were carried out at each randomly assigned station with a set of 4 Digby buckets (0.762 meters wide, 76 mm rings with rubber washers), 2 lined and 2 unlined. The catch of scallops in the lined (38 mm diagonal mesh liner) was used to estimate the catch of scallops <80 mm shell height, and the catch in the unlined buckets was used for scallops ≥ 80 mm shell height. Catches were standardized to an 800 m tow with a 7 bucket drag (800 m * 5.334 m = 4,267.2 m^2). Trends are examined in both stratified mean numbers of scallops per standard tow, and in mean scallop meat weight per standard tow. The strata used in the stratification of the 8-16 mile zone can be seen in Figure 2.

A separate analysis was conducted for the Cape Spencer area, for which there is an irregular series of surveys covering different areas, and with differences in the way they have been conducted. Surveys tows were again standardized to an 800 m tow with 7 buckets. Catches from older surveys that had been recorded in round weight were converted to meat weights by dividing by the conversion factor of 8.33, which is the conversion factor used by Statistics Branch. Station assignments were on a grid in 1987, 1996 and 1997, and randomly assigned in 1989, 1990, 1991 and 1998. Since the area surveyed varied from year to year, biomass estimates were calculated both for the entire survey area and for a polygon that was surveyed in all 7 years. The abundance estimates within this polygon were used to examine trends in biomass. Biomass was estimated by contouring using delauny triangulation, which does not provide confidence intervals, and with an arithmetic mean estimate, for which confidence intervals can be calculated.

CPUE's for Area 1 were calculated from the Full Bay logs for the 1976 to 1998 period. Mid Bay and Upper bay logs for 1992-1998 are also examined, but the data presented here is still preliminary as it is still being edited

Port sampling data for the Full Bay fleet was broken down into three areas; <8 miles from shore above Area 4; 8-16 miles offshore from Sandy cove to Hampton; and the remainder of Area 1. To examine changes in the size distribution of the catch with time, the meat weight frequencies by month were plotted for 1996 to 1998.

Results

Traditional Area surveys

Based on the mean number of scallops per standard tow for the 10 strata in the 8-16 mile survey, recruitment was low for the 1991-98 period (Tables 2 and 3). Patches of recruiting scallops were sometimes seen, such as in the Digby Gut area in 1994, and perhaps the areas from Centerville to Digby Gut appear to be improving, but the numbers seen here are still not high. There has been a decline in commercial sized scallops throughout the entire area, with the best catches coming from the south west half of the area (Table 3). The mean number per standard tow for all sizes for each stratum showed a decline through time over the survey area (Tables 4 and 5), down to low but relatively stable levels for the last few years. The plots of mean numbers by year (Figure 3) show this low level of recruitment. There is a non-significant increase in the

mean numbers per standard tow in 1998 (Table 6). When mean numbers and mean weight are compared (Figure 4) the 1998 increase in mean numbers is not seen in the mean weight, although the two lines track each other very closely.

The older surveys dating back to 1981 can be used to look at the longer term history, before the dramatic recruitment pulse of the late 1980's. These surveys are of different designs and sometimes slightly different areas, but serve to show the larger scale trends in the fishery (Figure 5). The present densities are still the lowest in this longer time series.

The survey shell height frequencies for the 8-16 mile area are shown in Figure 6 for the 1991 to 1998 surveys. This figure shows the decline in numbers per standard tow and a shift to smaller sized scallops. It also indicates a low but consistent level of recruitment in recent years.

Cape Spencer surveys

The contoured biomass estimates for the Cape Spencer area (Figures 7 to 13), and the simple and contoured estimates for the common polygon (Table 7) show the same trend as the traditional Digby area. The large recruitment pulse that was seen throughout the Bay of Fundy is apparent in the 1989 survey, which has the highest biomass estimate in the series. Since that time the biomass in the area has declined to the recent stable, but low levels.

The complete area surveyed in 1998 covers grounds that account for 83% of the 1998 landings according to logbook data (Figure 14). The survey took place in June, with 48% of the 1998 landings taking place after the survey.

Logbook data

The catch distribution for 1998 is shown in Figure 14. The Class 1 catch and effort in Area 1 for the 1976 to 1998 period from Full Bay logbooks (Table 8), shows the large recruitment pulse that entered the fishery in 1988 and 1989. This pulse can be seen with the highest CPUE in the time series recorded in 1989. Since then, CPUE has declined to the lowest levels in the time series, remaining stable for the last 3-4 years.

The catch rates from the Mid and Upper Bay logbooks (Table 9) show the same trend, with low but stable CPUE's for the last few years. The high standard deviations are expected to be reduced as editing of the database continues.

Port Sampling

The 1996-1998 data from the port samples for the Full Bay vessels in area 1 (Table 10), is broken down into three areas to match the breakdown of the surveys, <8 miles from shore above and below Area 4 (off Sandy Cove, Young Cove and Hampton); 8-16 miles off the Sandy Cove to Hampton area; and outside of these grounds. The meat weight distributions for the last three years, for the same three areas, indicate that the fishery was relying on fairly large scallops (Figures 15, 16 and 17). The 8-16 mile grounds off Digby were the only one of the three areas from which port samples were obtained for much of the year. There were no port samples taken in the 2-8 mile grounds in 1998, and only one sample from February for the >16 mile grounds. The 8-16 mile samples (Table 10 and Figure 16b), indicate that the size range being fished is diminishing. There are few small scallops in the catch, but also few larger ones.

Discussion

All indicators of the stock status in Area 1 show the same trend. There is a low biomass with recruitment levels balancing removals by fishing. The stock has declined from the historic high of 1988 and appears to have leveled off at low numbers in the last 3 to 4 years. This is seen in both the research surveys and in the commercial CPUE's. Landings in 1998 increased from the low of 1997, and are around the levels seen in the early 1980's, although at that time the CPUE's were much higher (Table 8). The survey estimates are below those seen in 1984-85, before the large recruitment pulse (Figure 5), but anecdotal evidence says the stock has been this low in the past. At present levels of effort, the removals from the stock in the traditional Digby and Cape Spencer areas, appear to be balanced by growth and a low level of recruitment. The trends, and the density of scallops, are very similar for both the 8-16 mile band from Sandy Cove to Hampton (that has regularly been surveyed), and the selected polygon on the Cape Spencer bed that has had an irregular series of surveys. There is a reduction in the size range in the port samples. Part of this is likely due to the combination of vessel quotas and a differential price based on meat count from the buyers. The plot of both mean numbers and weights per tow from the surveys (Figure 4), indicate a reduction in mean size through the period, with the recent higher levels of pre-recruits in the southwestern end of the survey area. In spite of this improvement, there are still no signs of a strong recruiting year class in the next few years. In

1997 landings in Area 1 were low for a combination of reasons; there was a two month closure for both the New Brunswick side of the Mid Bay line and the Upper Bay; and an opening of scallop fishing area 29 diverted effort from the Full Bay fleet for a month. In 1998 landings increased, and are at the levels seen in the early 1980's. These landings are being taken at much lower CPUE's, however, indicating that the stock is at a lower abundance than it was in the early 1980's.

Conclusion

The outlook for this stock is for low but stable abundance at the current exploitation rate. Area 1 is the largest SPA in the Bay of Fundy and so there will probably continue to be small patches of recruiting scallops scattered throughout the area. Effort in this area in 1999 will probably be similar to 1998. Our main concern is the low population levels because they are the lowest in our records. It is not known how low the abundance can go before the spawning stock is not able to produce an adequate number of recruits to increase the population, even if environmental conditions are good. Conditions at present appear to be stable at this low level, but it would not be advisable to increase effort at this time.

Bibliography

Chandler, R.A., G.J. Parsons and M.J. Dadswell. 1989. Upper and northern Bay of Fundy scallop surveys, 1986-87. Can. Tech. Rep. Fish. Aquat. Sci. 1665:37pp.

Ganong, W.F. 1889. The economic mollusca of Acadia. Bull. Nat. So. . New Brunswick 8:116pp.

Kenchington, E., D.L. Roddick and M.J. Lundy. 1995. Bay of Fundy Scallop analytical stock assessment and data review 1981-1994: Digby Grounds. DFO Atlantic Fisheries Research Document 95/10, 70pp.

Kenchington, E., I. Dempsey and M.J. Lundy. 1998. Peticodiac River Causeway Monitoring Programme: Scallops. Dept. of Fisheries and Oceans internal document. 16 pp.

Lescarbot, M. 1609. Histoire de la Nouvelle France. Paris.

Robinson, S.M.C. and R.A. Chandler. 1990. The Grand Manan scallop stock assessment 1988-1989. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 90/81. 26pp.

Robinson, S.M.C., J.D. Martin and R.A. Chandler. 1992. Grand Manan and Cape Spencer scallop stock update: 1990-1991. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 92/79. 23pp.

Smith, S. J. 1997. Bootstrap confidence limits for groundfish trawl survey estimates of mean abundance. Canadian Journal of Fisheries and Aquatic Science. 54:616--630.

Thompson, S. K. 1992. Sampling, John Wiley & Sons, New York, N.Y.

Table 1. Number of licenses issued and number of active vessels for each license type having access to Area 1.

	Mid-Bay*		Full Bay		Upper Bay	
Year	Licenses	Active	Licenses	Active	Licenses	Active
1978	n/a	n/a	88	n/a	n/a	n/a
1979	n/a	n/a	83	n/a	n/a	n/a
1980	135	n/a	90	n/a	n/a	n/a
1981	290	n/a	102	68	n/a	n/a
1982	278	n/a	104	66	n/a	n/a
1983	253	n/a	111	77	14	n/a
1984	262	n/a	104	82	14	n/a
1985	269	133	106	70	15	7
1986	238	127	98	67	13	10
1987	214	146	95	80	16	13
1988	211	130	99	91	16	15
1989	211	129	99	96	16	16
1990	210	145	99	94	16	16
1991	210	144	99	93	16	12
1992	206	143	98	90	16	12
1993	208	171	96	99	16	13
1994	209	178	96	92	16	10
1995	209	147	99	94	16	8
1996	208	149	99	96	16	1
1997	207	153	99	78	16	6
1998	207	130**	99	75**	16	9**

*Prior to 1987 these licenses were New Brunswick inshore licenses.
**Preliminary.

Table 2. Mean number of scallops <80 mm per standard tow by stratum and year for stratified random survey.

	Centreville	Gulliver's Head		Digby Gut		Delaps Cove		Young Cove	
		CV to GH	GH to DG		DG to DC		Parker's Cove		Hampton
1991	30.00	n/a	16.50	4.60	11.64	14.50	6.21	4.17	16.00	16.70
1992	10.83	n/a	13.67	6.75	31.75	68.17	15.50	41.75	13.75	16.83
1993	10.25	n/a	11.88	14.80	9.29	4.60	4.60	3.67	12.50	3.10
1994	n/a	17.00	17.88	27.12	111.93	31.88	16.75	6.50	7.33	3.13
1995	15.25	14.83	16.50	44.88	84.83	36.62	13.70	9.00	1.20	2.10
1996	15.12	7.50	22.00	19.17	23.13	24.88	12.08	12.50	7.60	8.30
1997	14.86	23.78	26.02	50.02	24.59	11.73	4.71	2.69	11.74	10.04
1998	25.34	32.29	43.17	33.10	22.79	13.02	14.62	6.70	9.49	3.51

Table 3. Mean number of scallops >=80 mm per standard tow by stratum and year for stratified random survey.

	Centreville	Gulliver's Head		Digby Gut		Delaps Cove		Young Cove	
		CV to GH	GH to DG		DG to DC		Parker's Cove		Hampton
1991	339.17	n/a	234.6	217.80	228.32	142.67	154.86	187.00	139.50	172.70
1992	280.67	n/a	262.2	184.50	131.75	135.17	132.50	114.75	125.25	198.50
1993	173.38	n/a	230.1	156.00	163.50	116.20	67.40	84.67	63.20	116.70
1994	n/a	116.8	170.1	145.75	131.43	102.25	77.12	73.57	53.42	38.12
1995	132.12	140.3	146.4	65.12	97.56	58.50	56.90	40.17	18.90	36.70
1996	89.88	28.0	141.0	120.17	76.81	68.25	34.17	50.25	40.10	46.30
1997	60.35	115.8	137.3	113.30	112.48	51.78	23.26	32.56	22.95	26.17
1998	47.99	106.5	97.3	143.08	93.17	84.77	44.12	45.03	40.69	39.48

Table 4. Mean number of scallops of all sizes per standard tow by stratum and year for stratified random survey.

	Centreville	Gulliver's Head		Digby Gut		Delaps Cove		Young Cove	
		CV to GH	GH to DG		DG to DC	Parker's Cove			Hampton
1991	369.17	n/a	251.1	222.4	239.95	157.17	161.07	191.17	155.50	189.40
1992	291.50	n/a	275.8	191.2	163.50	203.33	148.00	156.50	139.00	215.33
1993	183.62	n/a	242.0	170.8	172.79	120.80	72.00	88.33	75.70	119.80
1994	n/a	133.8	188.0	172.9	243.36	134.12	93.88	80.07	60.75	41.25
1995	147.38	155.2	162.9	110.0	182.39	95.12	70.60	49.17	20.10	38.80
1996	105.00	35.5	163.0	139.3	99.94	93.12	46.25	62.75	47.70	54.60
1997	75.21	139.6	163.3	163.3	137.07	63.52	27.98	35.25	34.69	36.21
1998	73.33	138.8	140.5	176.2	115.97	97.79	58.74	51.73	50.19	42.99

Table 5. Stratified mean number of scallops per standard tow over all strata for stratified random survey.

	<80	SE	Lower	Upper	>=80	SE	Lower	Upper	Total	SE	Lower	Upper
1991	13.485	2.892	8.236	19.80	204.52	23.643	160.50	249.70	218.00	25.708	170.6	269.7
1992	24.016	6.447	12.260	36.03	172.36	16.781	141.40	203.30	196.37	21.981	158.2	235.6
1993	8.274	1.377	5.663	10.80	131.65	12.246	109.20	156.90	139.93	12.611	117.4	166.7
1994	32.026	7.925	17.550	48.58	100.46	8.955	82.77	117.78	132.48	12.816	108.8	159.6
1995	26.688	5.304	17.520	37.65	77.94	8.973	61.99	97.43	104.63	11.444	85.2	127.6
1996	15.692	2.221	14.170	20.92	70.76	7.271	57.13	85.58	86.45	7.932	71.4	102.1
1997	17.385	1.778	18.530	22.76	68.74	5.214	58.63	78.56	86.12	5.683	74.5	97.0
1998	19.759	2.071	15.88	23.73	71.42	5.965	59.71	82.72	91.19	7.046	76.9	104.2

Stratified mean numbers with associated standard errors (Thompson, 1992). Bootstrap confidence limits for 95% CI's (1000 reps, BWR method, Smith 1997).

Table 6. Stratified mean number of scallops per standard tow over all strata for <8 m part of Eastern Bay of Fundy.

	<80	SE	>=80	SE	Total	SE
1991	7.300	3.105	72.100	13.181	75.900	13.956
1996	4.500	3.414	49.200	14.002	53.700	14.579
1997	5.233	2.090	25.700	5.728	30.933	6.297
1998	7.748	2.460	35.026	9.715	42.774	11.833

Table 7. Biomass estimates (kg meat weight) for a polygon of 331.2 square kilometers falling within the surveyed area in all 7 surveys conducted in the Cape Spencer area.

Year	Standard Biomass Estimate	Contoured Biomass Estimate
1987	230,960 ± 47,300	230,329
1989	594,986 ±165,151	550,340
1990	168,493 ± 66,625	145,956
1991	187,325 ± 73,638	193,170
1996	59,840 ± 22,033	52,240
1997	38,173 ± 14,986	38,182
1998	64,361 ± 18,623	62,505

Table 8. Historic trends in Area 1 from Full Bay logbooks. Class 1 data is logbook records for which all catch effort and location information is complete. Total effort is in 1000 h, and is estimated from total catch and Class 1 CPUE. The number of Class 1 log records used to estimate the CPUE is "n". Matching of the database to the new SPA's is not complete so these numbers are preliminary.

Year	# Vessels	Total * Catch(t)	Logged Catch(t)	% Logged	Class 1 Catch	Class 1 Effort (h)	Total Effort	Average CPUE	n	Standard Deviation
80	33	179	92	52	92	2,989	5.34	33.5	490	15.2
81	39	215	69	32	69	2,205	6.42	33.5	343	18.9
82	34	167	85	51	82	2,671	5.11	32.7	434	16.0
83	57	283	201	71	174	9,312	14.01	20.2	1,342	9.1
84	59	297	230	78	214	14,297	17.17	17.3	1,918	11.6
85	55	326	239	73	220	16,865	23.12	14.1	1,913	6.9
86	34	266	68	26	63	5,396	21.28	12.5	663	5.8
87	19	561	45	8	44	2,656	23.18	24.2	342	30.3
88	14	756	81	11	64	2,241	21.91	34.5	305	25.3
89	20	1,855	168	9	121	2,968	40.77	45.5	412	30.6
90	13	2,089	266	13	218	8,127	71.54	29.2	871	16.0
91	19	710	151	21	95	4,873	34.30	20.7	498	15.2
92	49	961	730	76	541	26,257	43.09	22.3	2,608	13.3
93	56	602	296	49	176	13,098	43.00	14.0	1,146	5.6
94	61	232	152	66	73	6,268	19.50	11.9	599	4.9
95	63	373	219	59	131	15,284	42.39	8.8	1,302	3.0
96	61	186	110	59	67	8,587	23.54	7.9	843	3.5
97	79	119	113	95	101	15,949	18.03	6.6	1,866	3.0
98	64	188	153	81	136	20,013	26.86	7.0	2,044	2.6

* 1980-1996 estimated by prorating total Full Bay landings by logbook data, accuracy varies with the number of vessels submitting logbooks. 1997 is the first year for which landings were recorded by the new SPA's by Statistics Branch.

Table 9. Historic trends in Area 1 from Mid and Upper Bay logbooks. Class 1 data is logbook records for which all catch effort and location information is complete. Total effort is in 1000 h, and is estimated from total catch and Class 1 CPUE. The number of Class 1 log records used to estimate the CPUE is "n". Matching of the database to the new SPA's is not complete so these numbers are preliminary.

Year	# Vessels	Total * Catch(t)	Logged Catch(t)	% Logged	Class 1 Catch	Class 1 Effort (h)	Total Effort	Average CPUE	n	Standard Deviation
92	3		22,187		8,535	764.9		13.65	93	10.72
93	5		28,814		25,110	2,060.7		18.69	163	32.60
94	15		48,131		37,244	4,290.1		8.86	438	3.89
95	16		20,399		11,181	1,747.4		6.58	121	2.38
96	30		19,986		18,819	7,046.4		5.16	310	6.12
97	48	23.2	21,549	93	20,306	4,342.9	4.44	5.23	572	5.98
98	45	43.2	43,903	102	40,809	6,886.1	6.53	6.62	894	22.27

* 1997 is the first year for which landings were recorded by the new SPA's by Statistics Branch.

Table 10. Meat weight data for Port Samples from Full Bay vessels in Area 1 for 1996-1998.

Year	Month	N	Mean	Standard Deviation	Min	Max	Count	Total Weight Sampled
Area 1 (< 8 miles Sandy Cove, Young Cove, & Hampton)								
96	3	109	22.45	8.68	4.9	37.5	22.3	2446.9
96	4	65	22.07	10.32	5.9	52.5	22.7	1434.5
96	9	35	16.95	3.86	8.0	25.4	29.5	593.3
97	2	446	19.53	7.08	5.3	38.9	25.6	8709.6
97	3	460	18.42	7.24	4.3	49.2	27.1	8471.7
97	4	38	22.09	6.64	9.4	35.4	22.6	839.3
97	5	216	16.04	5.84	4.0	38.4	31.2	3465.2
97	7	249	15.11	6.47	6.1	37.5	33.1	3762.8
97	8	86	23.92	10.41	7.6	44.4	20.9	2057
97	9	183	22.76	8.04	4.7	40.0	22.0	4164.9
97	10	88	25.03	5.95	15.9	38.8	20.0	2202.8
Area 1 (Outside Traditional Fishing grounds)								
96	2	284	16.51	7.49	5.1	36.8	30.3	4689.8
96	3	299	15.03	8.12	3.7	39.1	33.3	4494.0
96	4	523	14.17	8.15	3.1	40.4	35.3	7410.0
96	5	550	14.27	6.57	3.2	39.6	35.0	7850.5
96	6	198	20.00	9.47	2.0	51.0	25.0	3960.7
96	7	36	18.6	1.95	14.6	24.1	26.9	669.5
96	8	1152	11.19	5.16	4.0	31.0	44.7	12894.4
96	9	252	17.73	5.01	7.3	32.1	28.2	4467.7
96	10	154	15.41	4.72	5.2	26.8	32.4	2372.8
96	11	150	18.85	8.2	4.3	46.8	26.5	2827.7
96	12	476	9.53	2.13	4.8	19	52.5	4536.7
97	3	194	16.98	7.95	4.0	43.1	29.4	3293.2
97	4	448	15.91	5.22	3.2	34.9	31.4	7127.3
97	5	118	13.24	5.57	2.5	24.4	37.8	1562.1
97	6	119	18.10	2.27	12.9	25.4	27.6	2154.4
98	2	117	15.86	4.68	6.9	30.4	31.5	1855.4

Table 10 continued. Meat weight data for Port Samples from Full Bay vessels in Area 1 for 1997.

Year	Month	N	Mean	Standard Deviation	Min	Max	Count	Total Weight Sampled
Area 1 (Traditional Fishing grounds 8-16 miles Sandy Cove - Hampton)								
96	1	93	11.76	6.42	5.4	36.4	42.5	1093.9
96	2	438	14.43	7.73	3.9	38.3	34.7	6321.4
96	3	348	17.72	8.89	3.6	43.5	28.2	6166.9
96	4	458	16.90	8.14	4.0	52.7	29.6	7741.0
96	5	103	14.37	7.23	3.6	31.2	34.8	1480.6
96	6	366	11.71	5.38	3.4	33.5	42.7	4287.2
96	7	246	13.65	5.78	4.6	30.6	36.6	3357.8
96	8	612	9.93	3.61	4.3	31.4	50.4	6075.7
96	9	37	16.53	4.1	8.9	24.7	30.2	611.6
96	11	328	7.72	2.55	5.0	23.2	64.8	2532.3
96	12	225	10.09	3.65	5.1	34.5	49.6	2270.7
97	2	351	19.73	4.99	5.8	35.1	25.3	6924.4
97	3	755	19.17	5.67	7.0	57.3	26.1	14474.1
97	4	648	17.18	3.61	3.0	30.6	29.1	11132.9
97	5	775	16.98	4.32	4.1	30.9	29.4	13162.5
97	6	473	18.35	3.77	8.7	31.1	27.2	8678.0
97	7	975	14.51	7.00	3.9	52.0	34.5	14144.7
97	8	511	14.40	6.57	6.4	41.8	34.7	7358.4
97	9	827	21.40	8.13	3.7	46.2	23.4	17698.9
97	10	198	22.72	4.38	16.2	37.4	22.0	4497.6
97	12	508	23.61	3.97	16.2	39.8	21.2	11992.8
98	1	49	25.36	10.85	13.3	52.5	19	1242.5
98	2	722	17.46	2.64	11.9	34.9	28	12606.1
98	3	125	18.56	4.67	12.5	30.7	26	2320.5
98	4	786	16.38	2.39	7.0	25.9	30	12872.6
98	5	473	17.63	2.85	6.4	34.1	28	8338.0
98	6	271	18.68	1.46	15.1	23.2	26	5063.3
98	7	503	19.35	2.81	15.0	33.3	25	9734.8
98	8	313	19.10	1.78	15.0	23.5	26	5976.9
98	9	534	18.38	4.16	7.2	37.5	27	9815.1

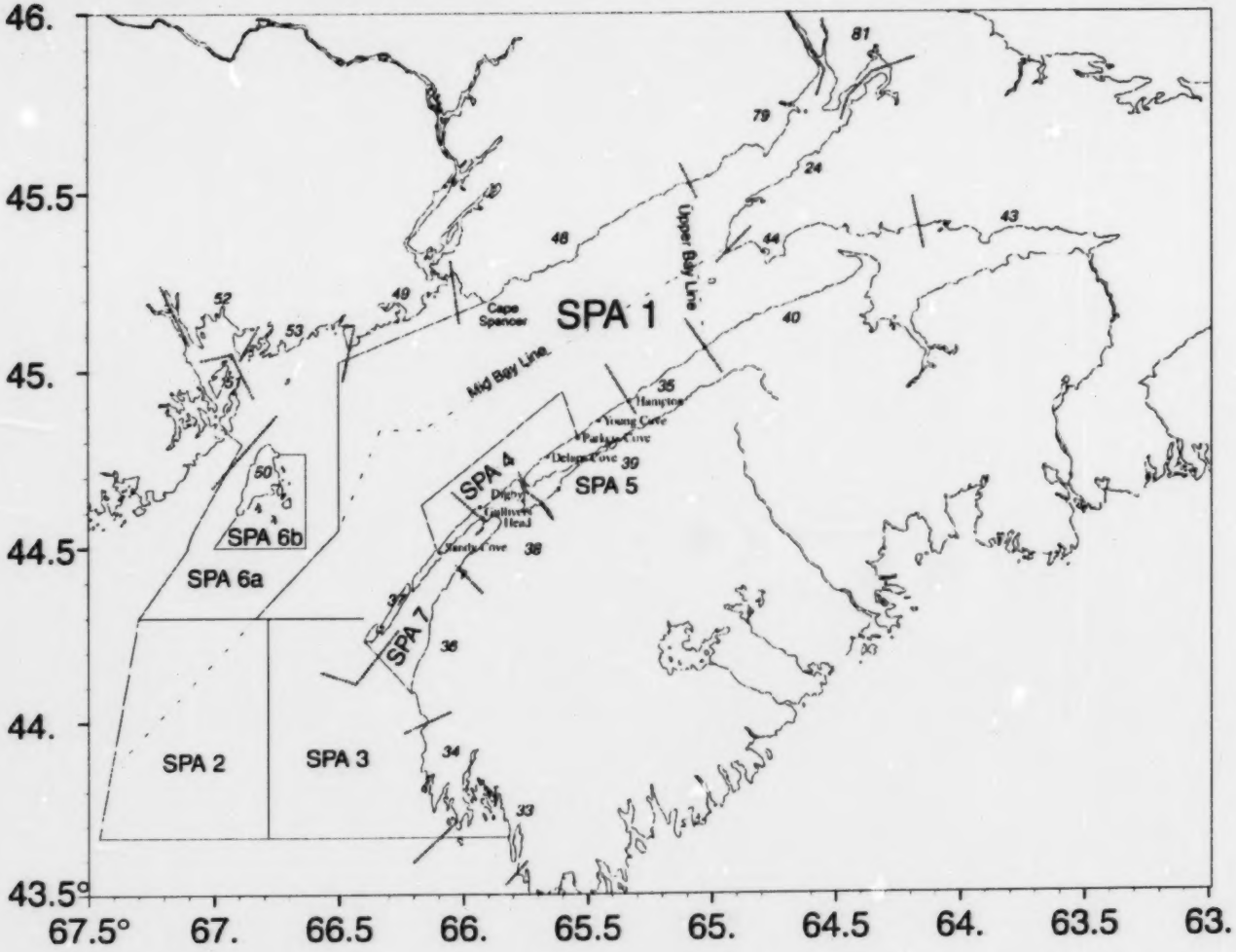

Figure 1. - Scallop Production Areas (SPA's), regulated lines and Statistical Districts in the Bay of Fundy.

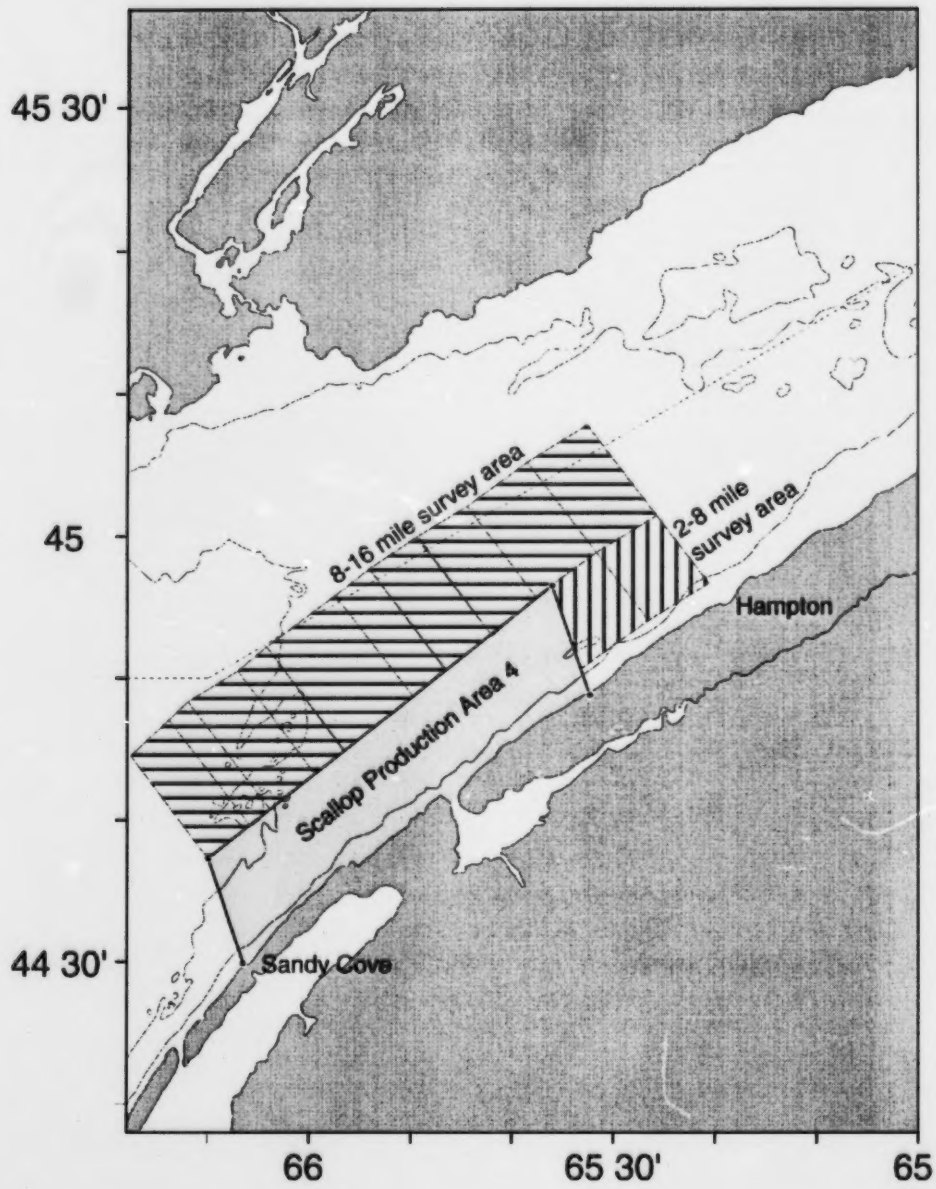

Figure 2. - The 8-16 and 2-8 mile sections of Area 1 that have a consistent series of annual surveys.

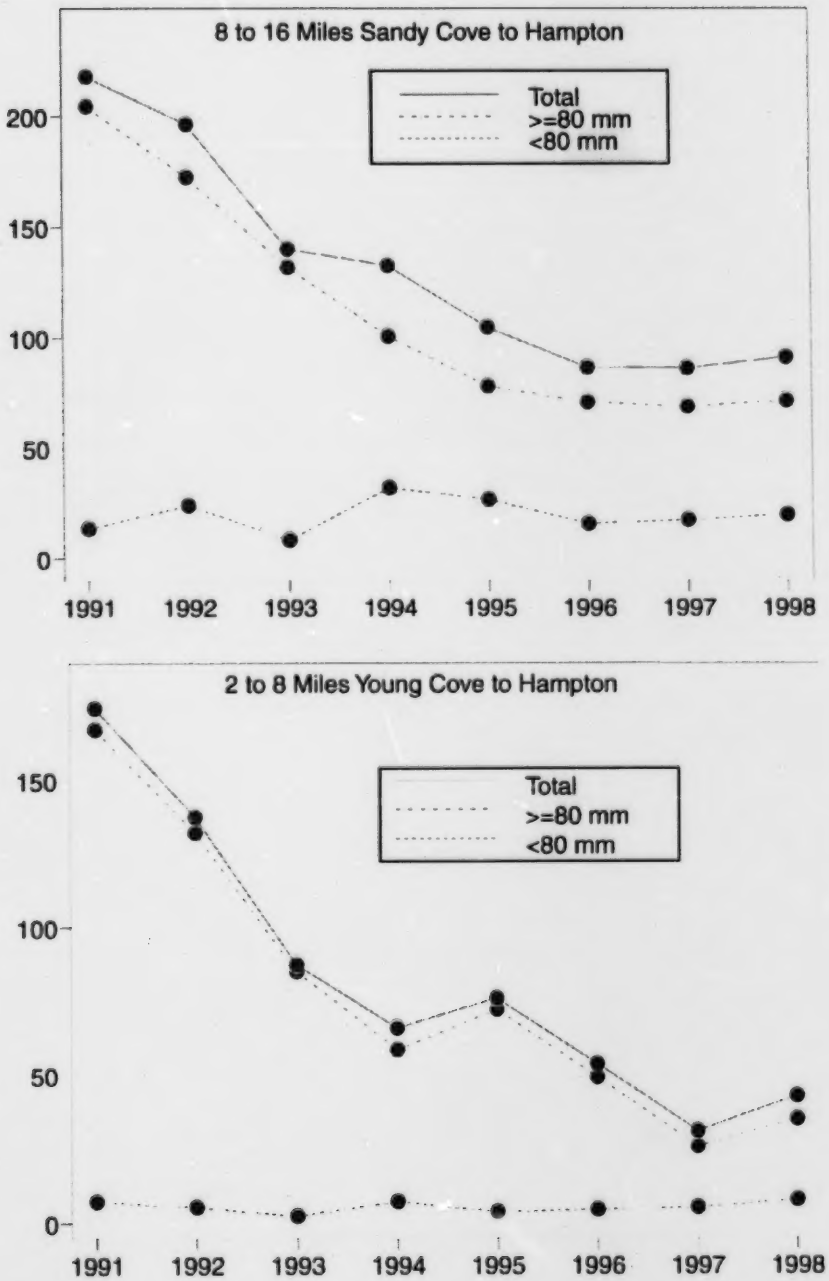

Figure 3. Trends in stratified mean number of scallops per standard tow for the Digby 2-8 and 8-16 mile grounds of Area 1.

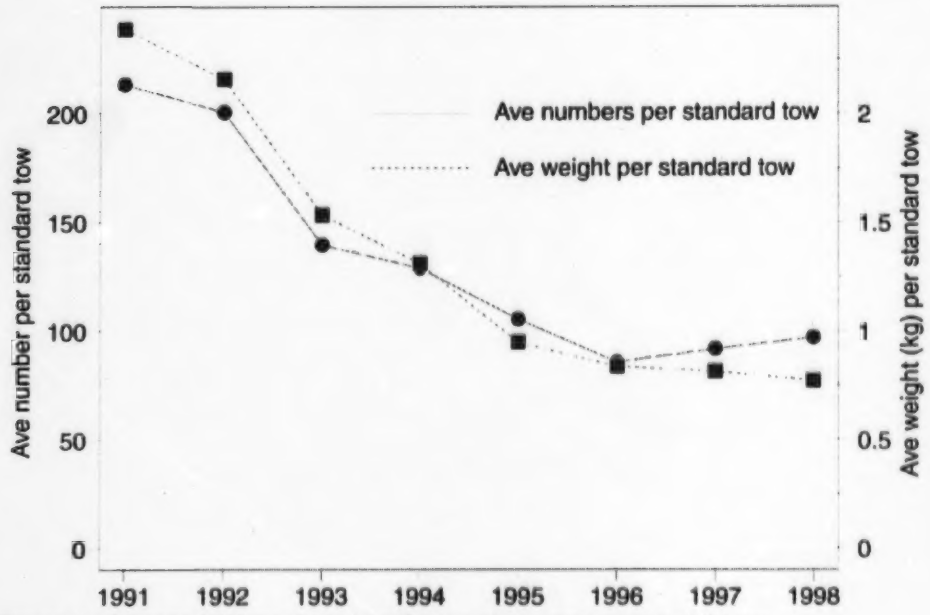

Figure 4. Average total number of scallops and average meat weight per standard tow for the traditional 8 to 16 mile area off Sandy Cove to Hampton.

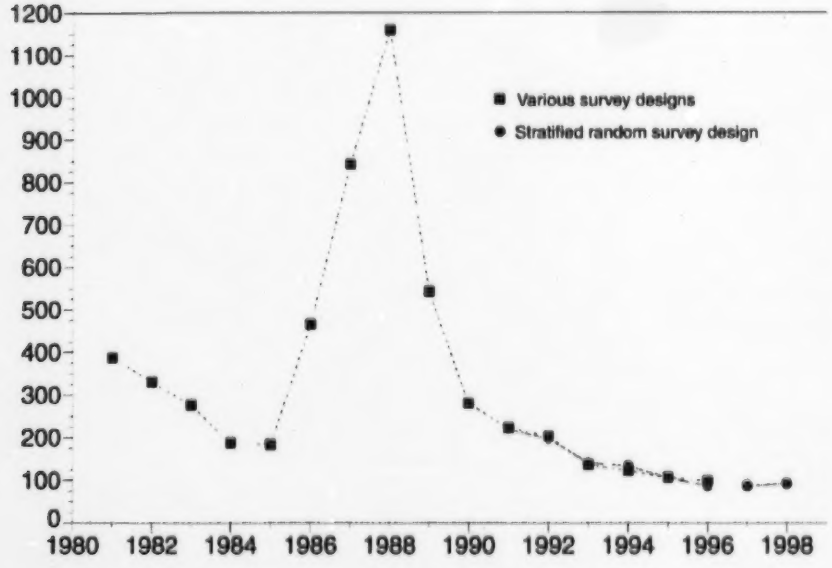

Figure 5. Long term trend in Survey estimates of scallop densities for the 8-16 mile area from Sandy Cove to Hampton.

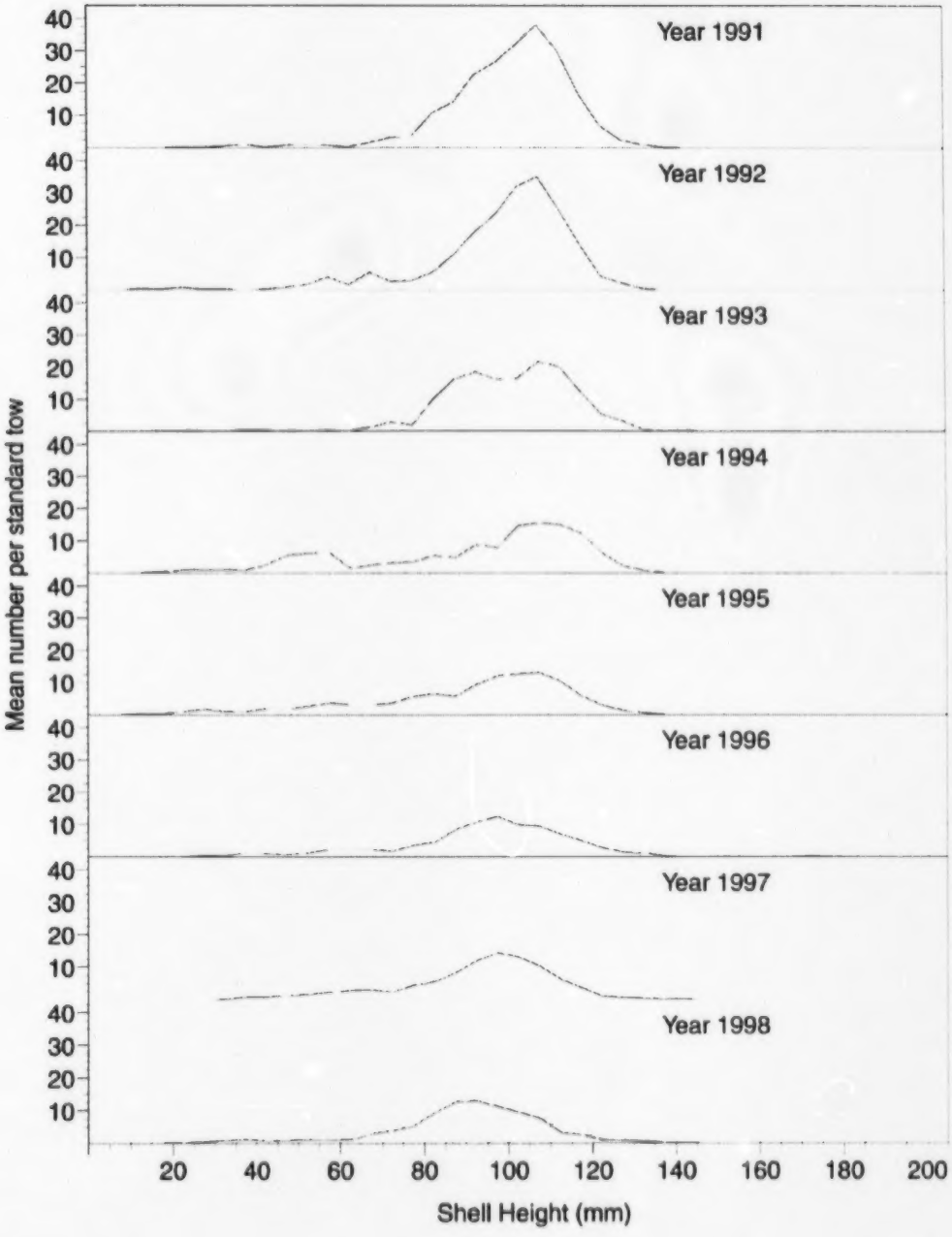

Figure 6. Survey estimates of the mean number of scallops per standard tow at height for the area 8-16 miles offshore from Sandy Cove to Hampton, Nova Scotia.

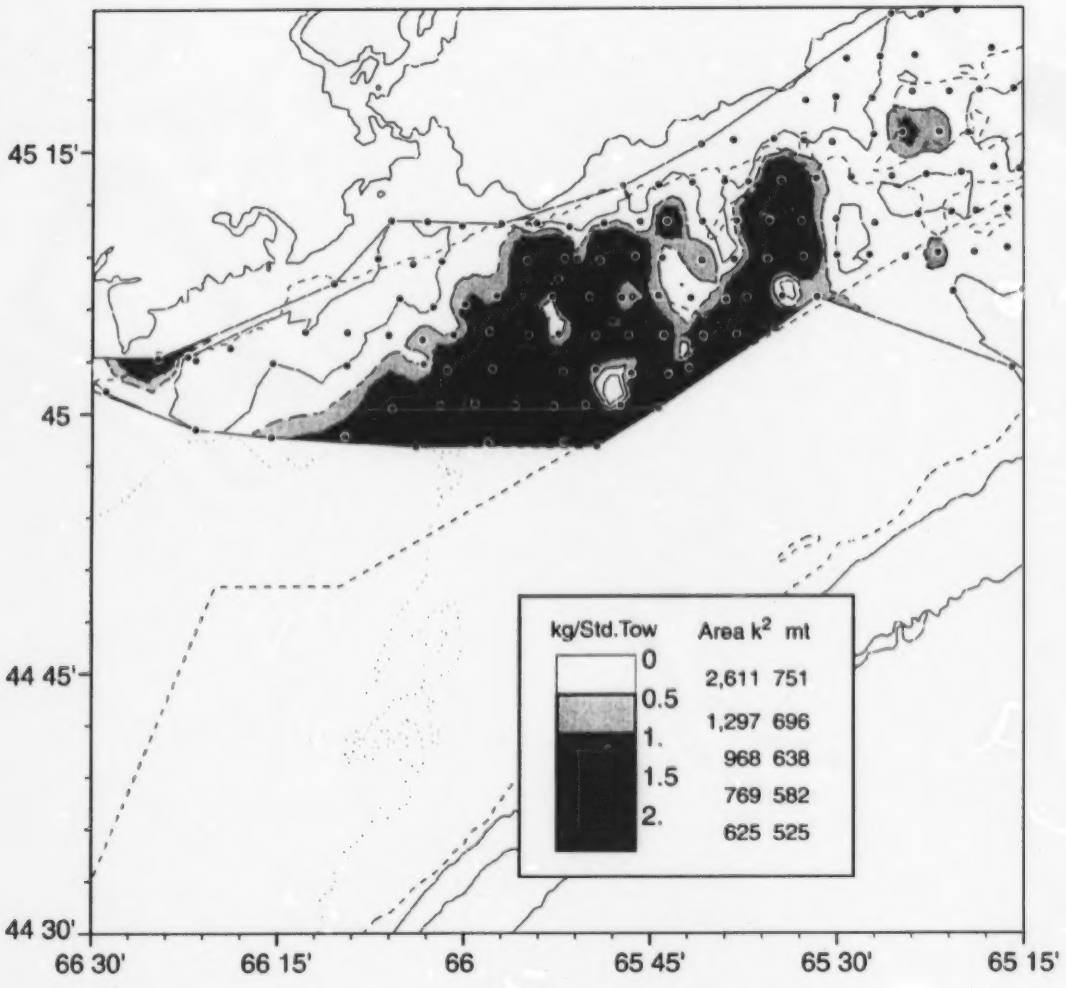

Figure 7.- Total meat weight for scallops >= 80mm per standard tow for the 1986 survey. Dashed line shows polygon common to all seven surveys that was used to examine trends in biomass.

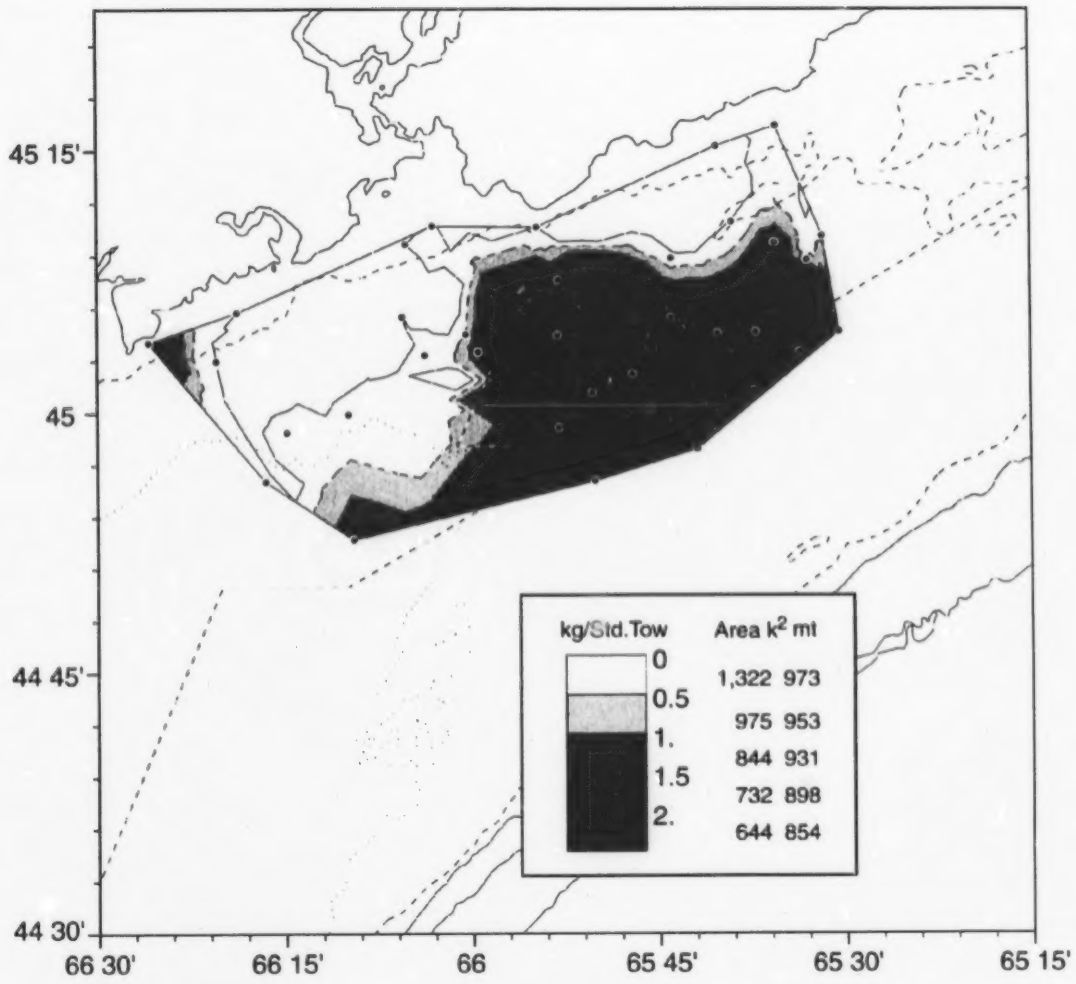

Figure 8.- Total meat weight for scallops >= 80mm per standard tow for the 1989 survey. Dashed line shows polygon common to all seven surveys that was used to examine trends in biomass.

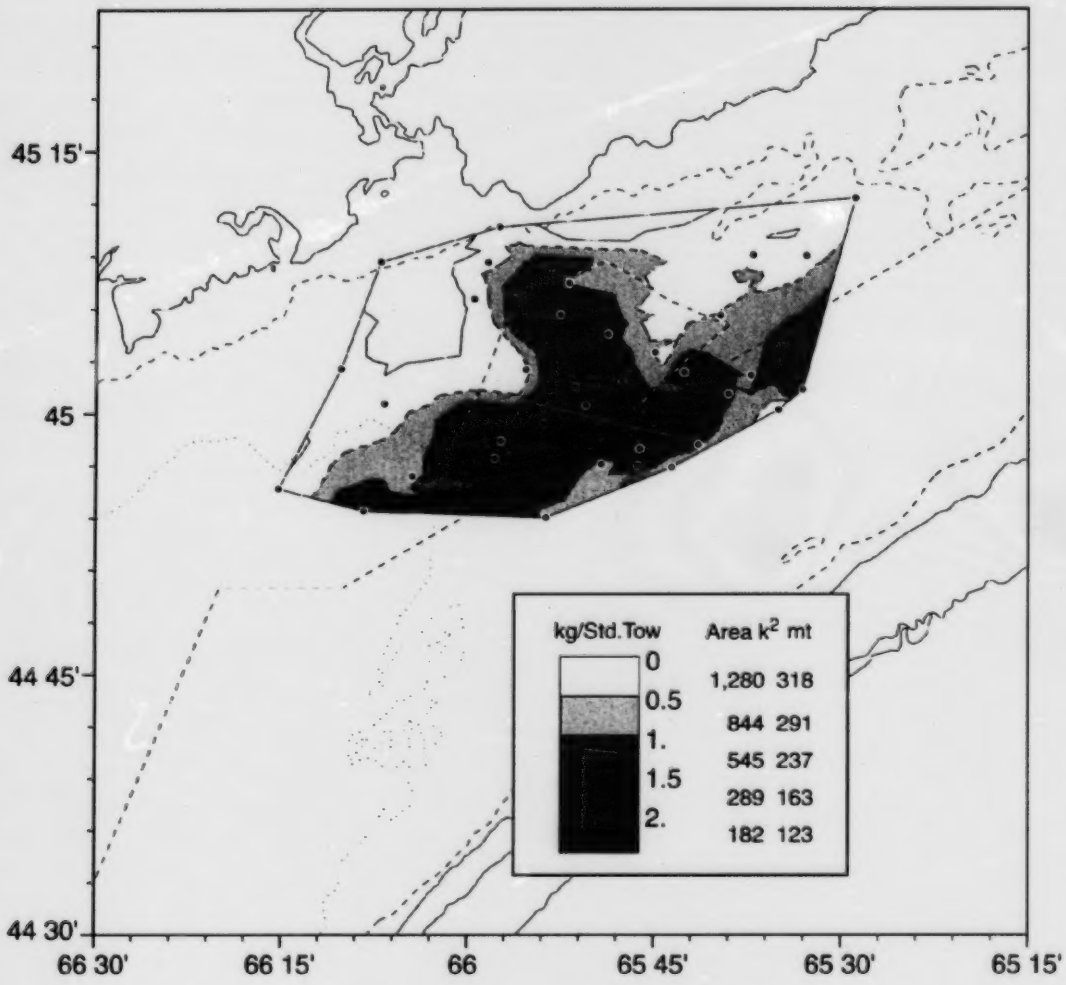

Figure 9. Total meat weight for scallops >= 80mm per standard tow for the 1990 survey. Dashed line shows polygon common to all seven surveys that was used to examine trends in biomass.

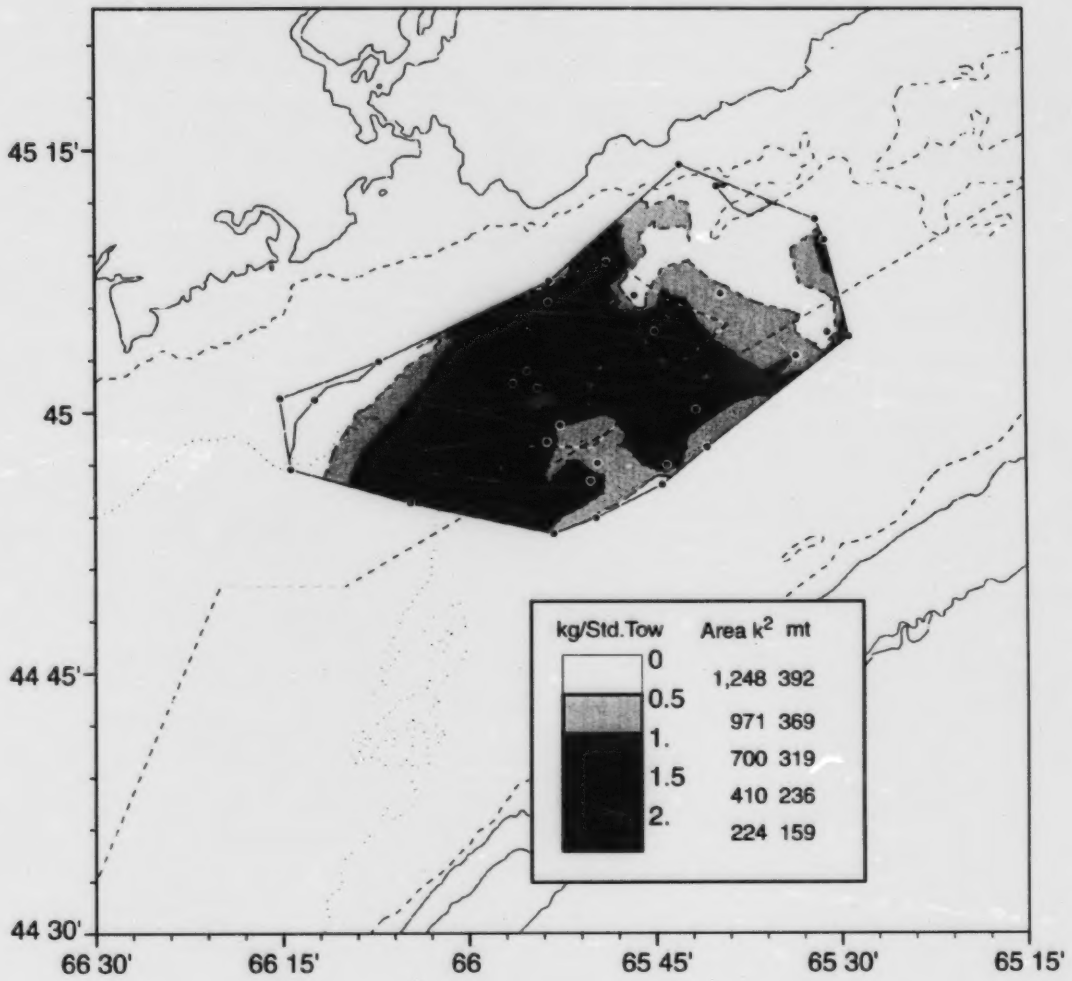

Figure 10. Total meat weight for scallops >= 80mm per standard tow for the 1991 survey. Dashed line shows polygon common to all seven surveys that was used to examine trends in biomass.

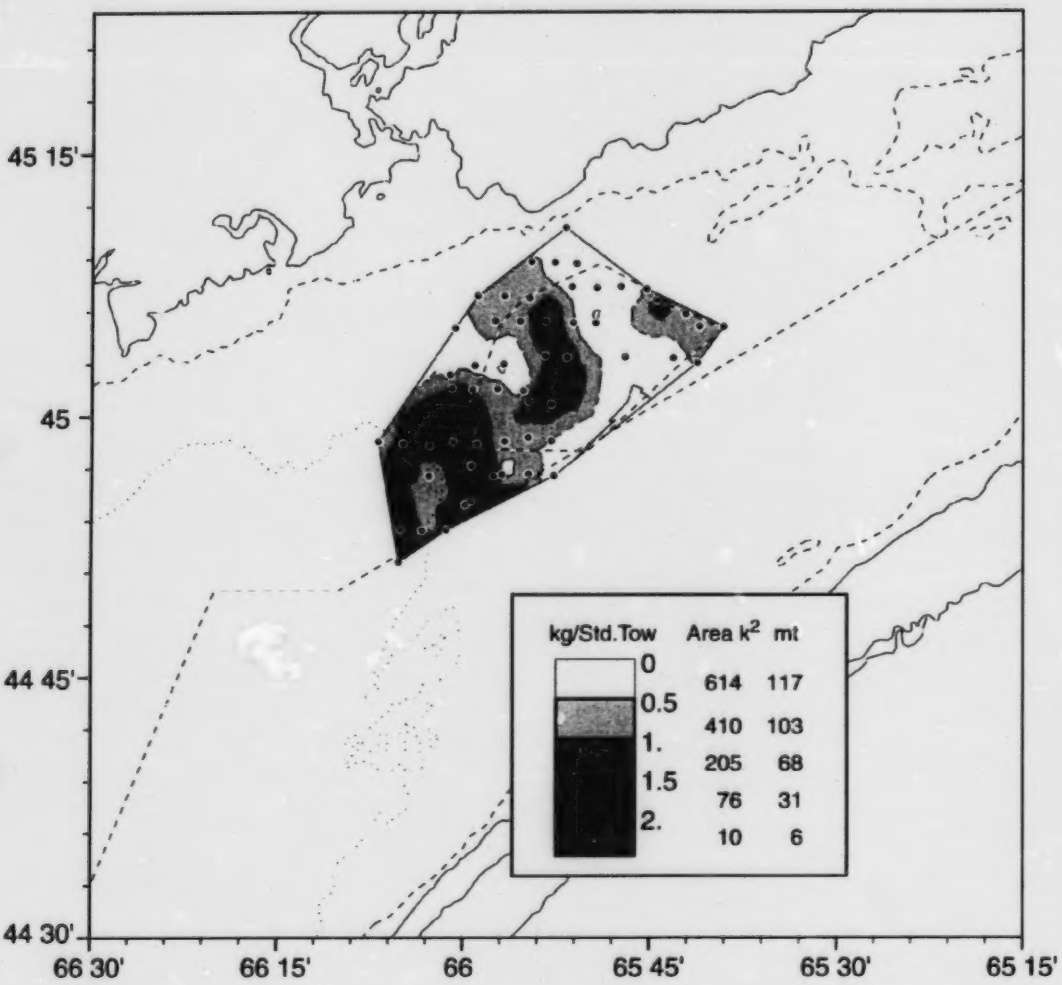

Figure 11. Total meat weight for scallops >= 80mm per standard tow for the 1996 survey. Dashed line shows polygon common to all seven surveys that was used to examine trends in biomass.

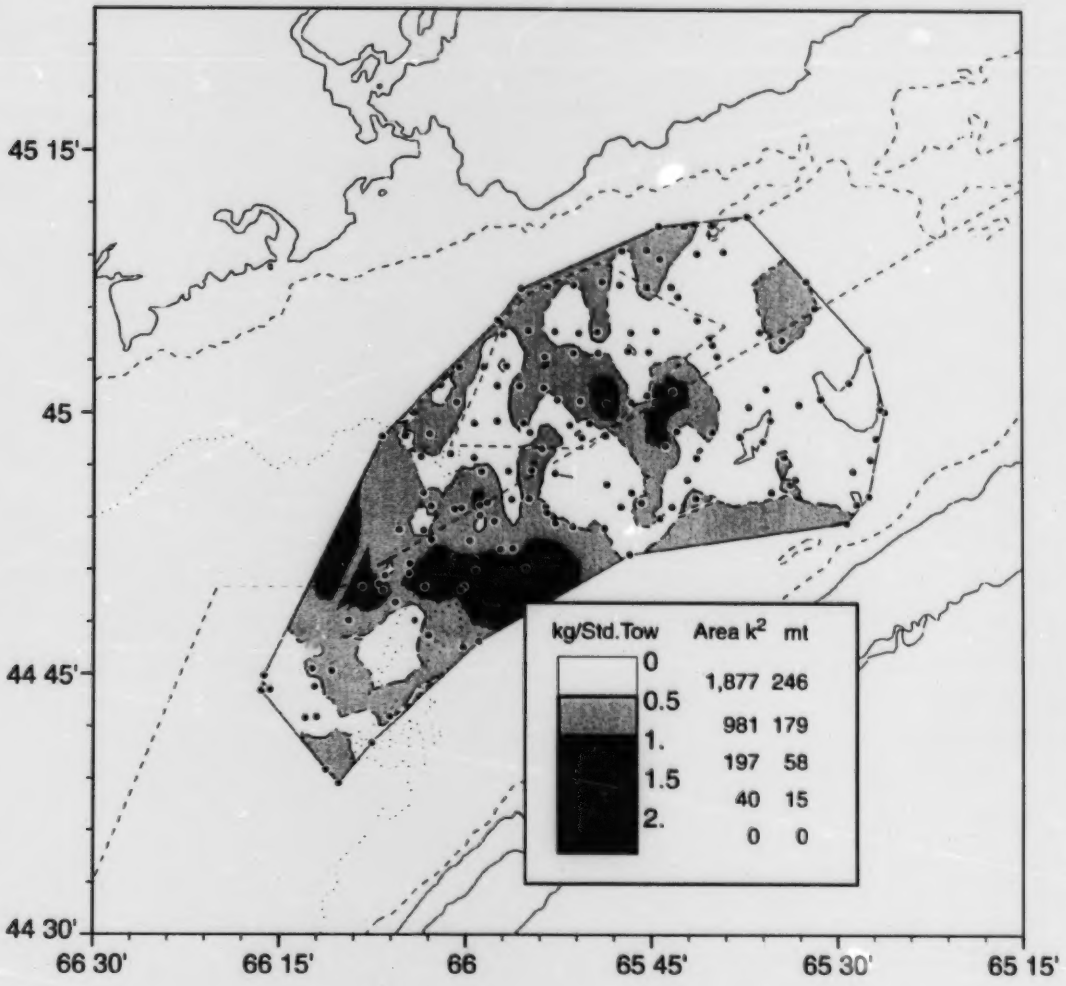

Figure 12.- Total meat weight for scallops >= 80mm per standard tow for the 1997 survey. Dashed line shows polygon common to all seven surveys that was used to examine trends in biomass.

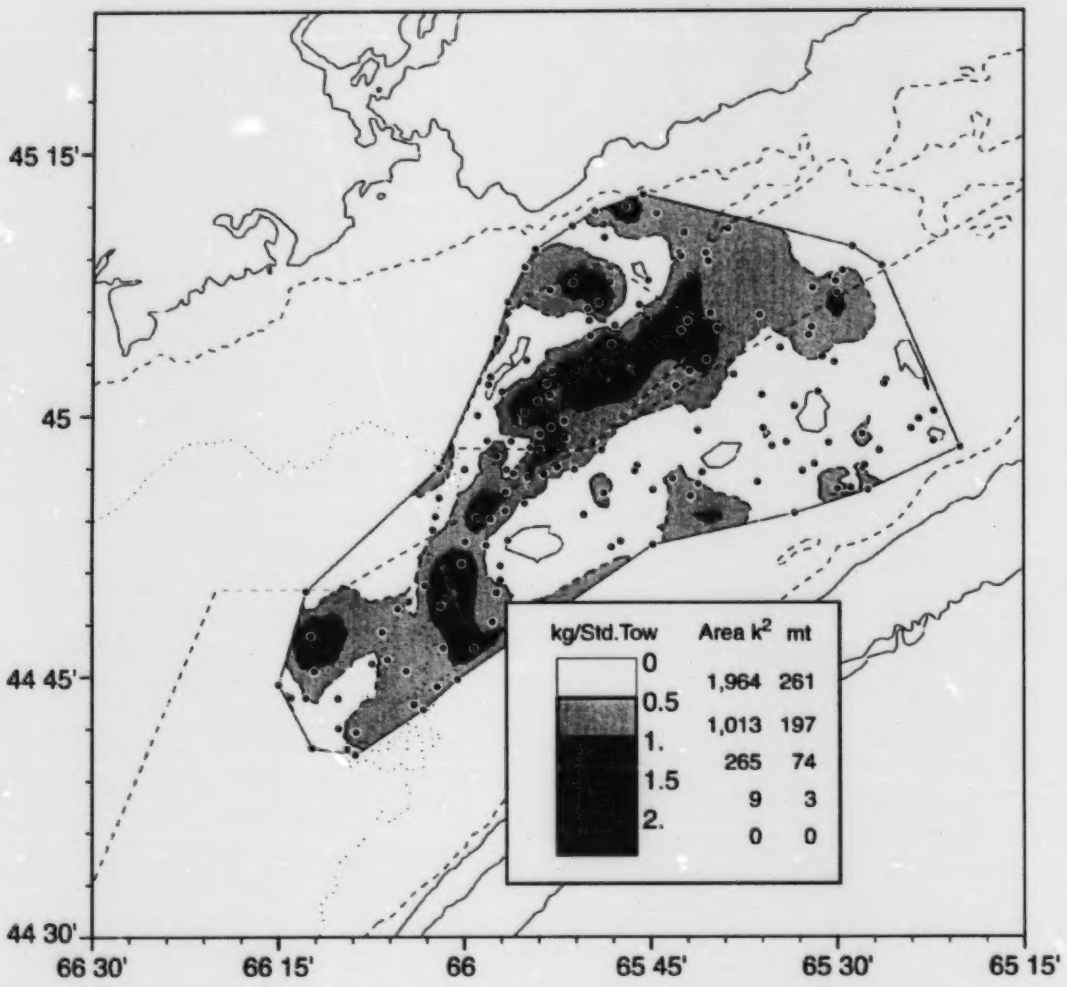

Figure 13.- Total meat weight for scallops >= 80mm per standard tow for the 1998 survey. Dashed line shows polygon common to all seven surveys that was used to examine trends in biomass.

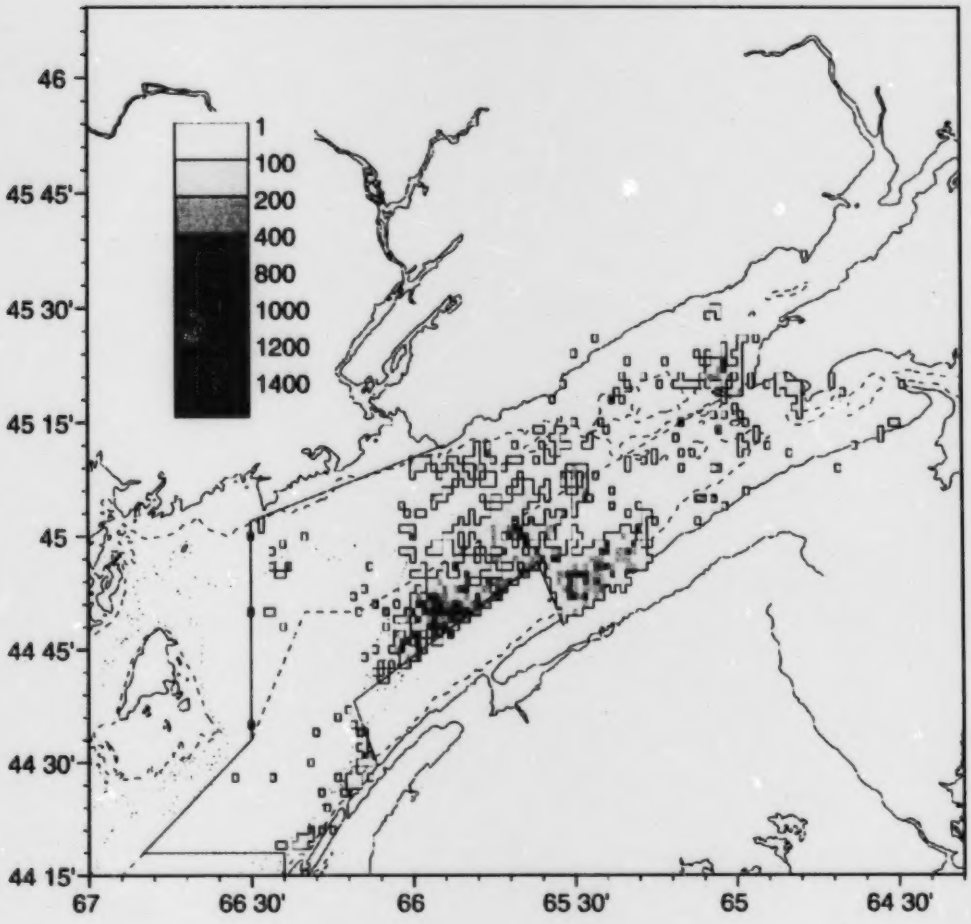

Figure 14. Catch (kg of meats) aggregated by one minute squares for SPA 1 in 1998. Data is from Full, Mid and Upper Bay logs Class 1 catch, i.e. records having location, effort and catch recorded.

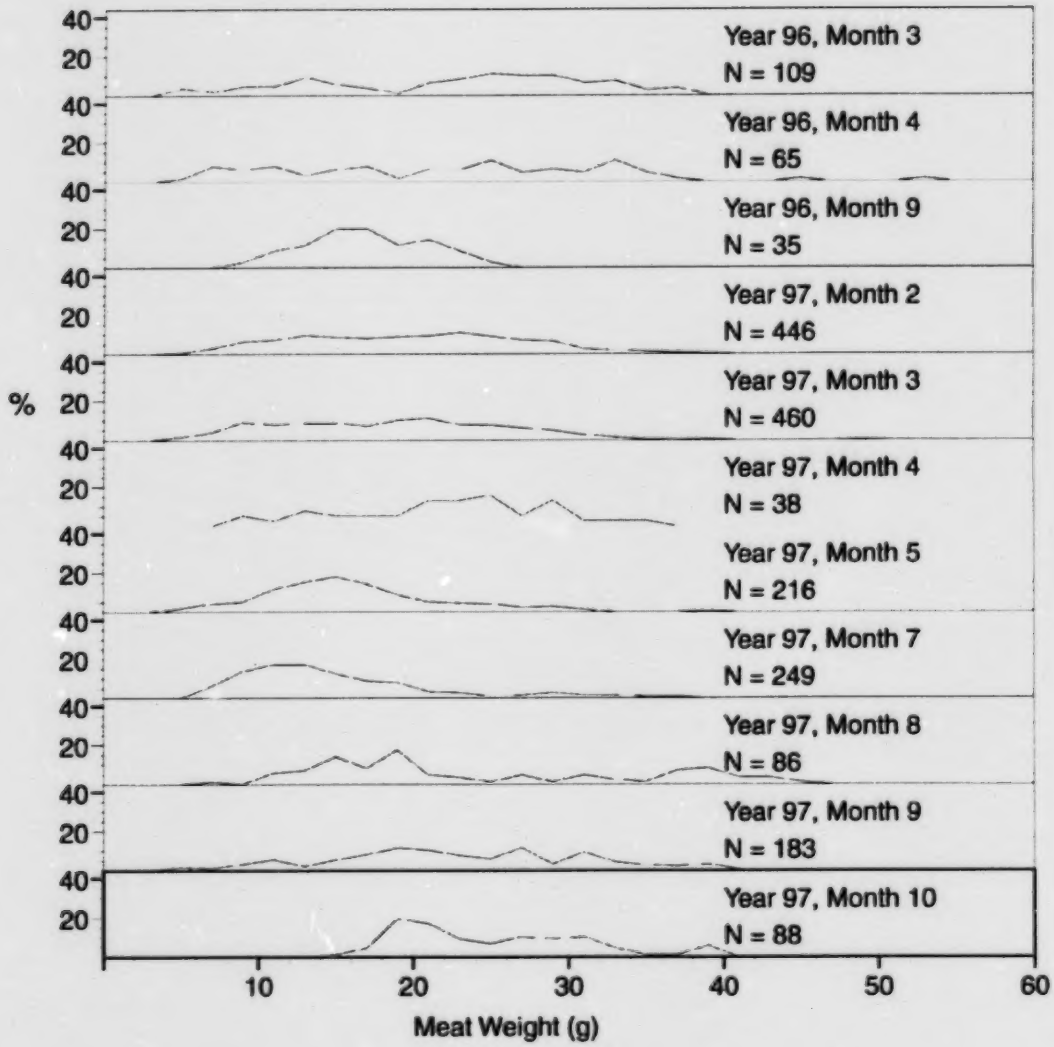

Figure 15. Meat weight distribution for port samples for vessels fishing in Area 1 inside 8 miles from shore from Sandy Cove to Hampton. There were no port samples obtained from this area in 1998.

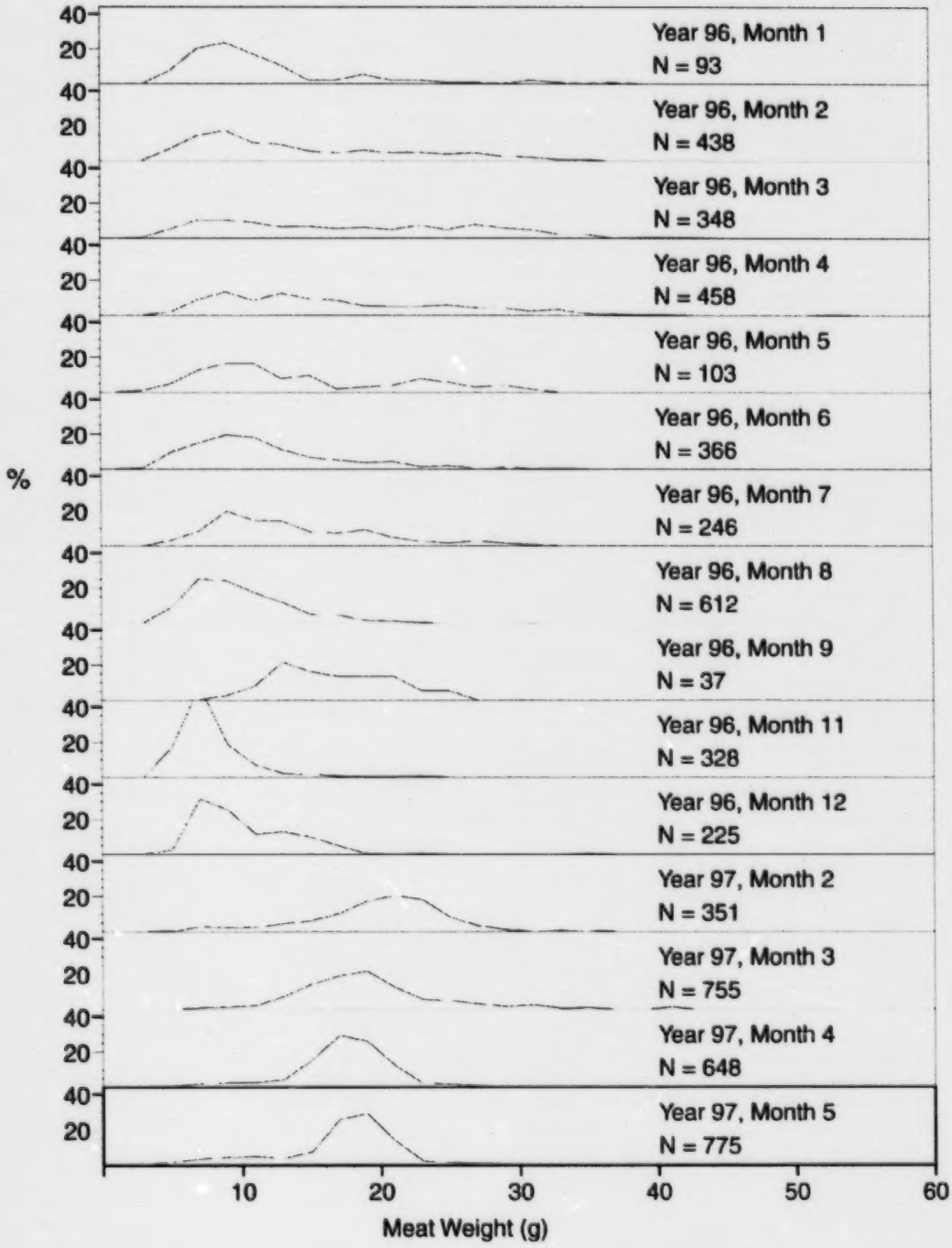

Figure 16. Meat weight distribution for port samples for vessels fishing in the Digby outer area (8-16 miles from shore, from Sandy Cove to Hampton).

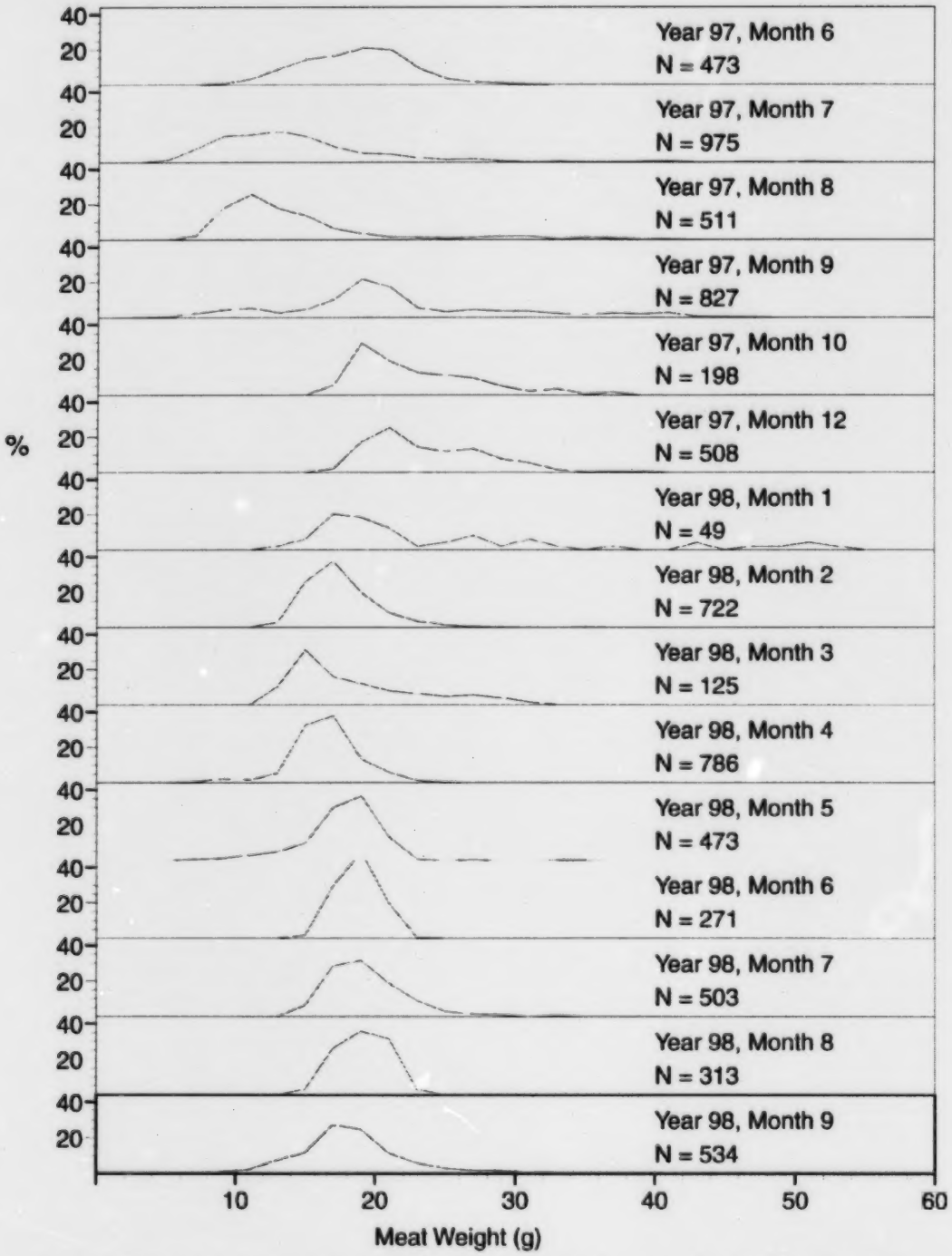

Figure 16b. Meat weight distribution for port samples for vessels fishing in the Digby outer area (8-16 miles from shore, from Sandy Cove to Hampton).

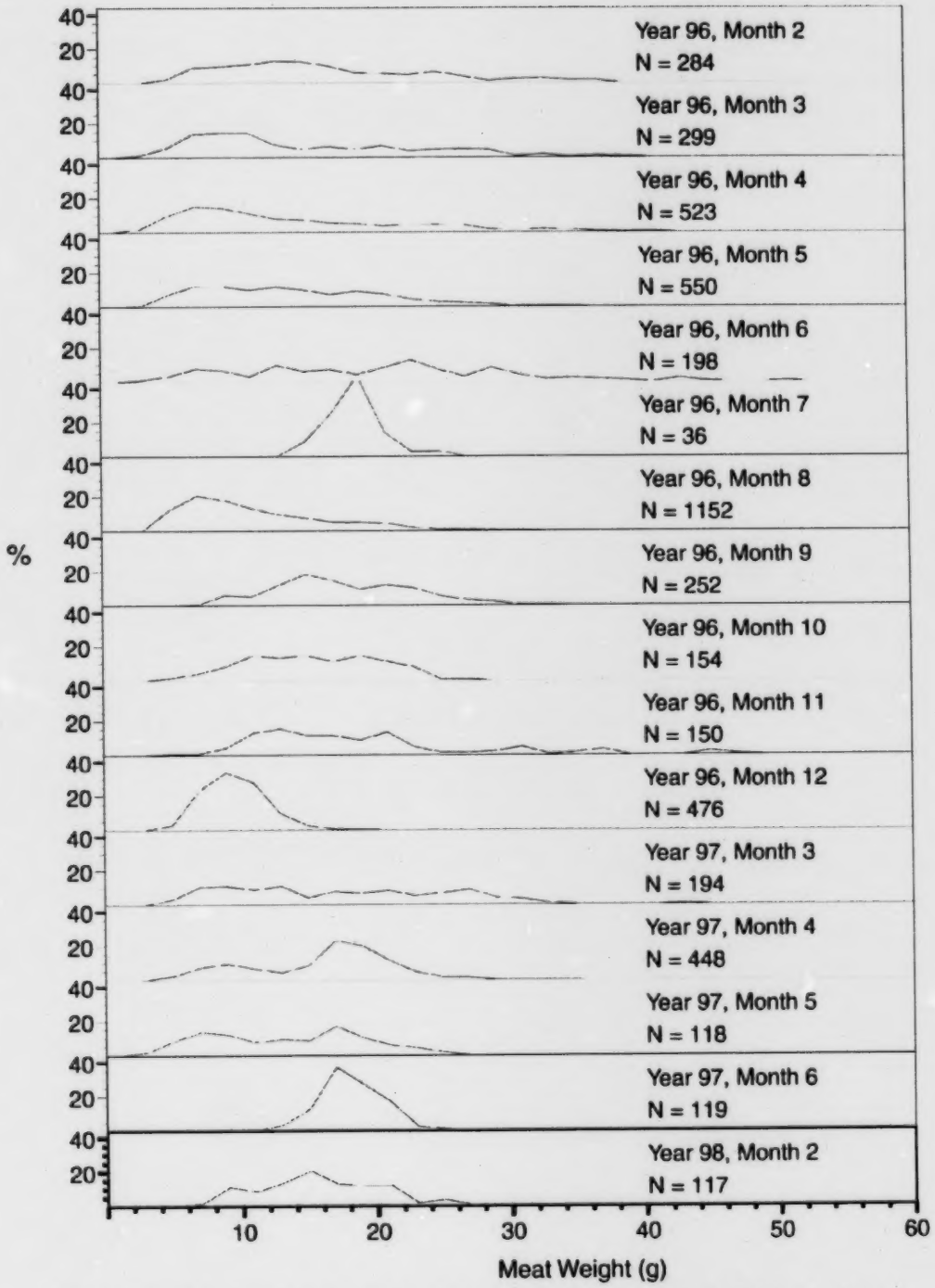

Figure 17. Meat weight distribution for port samples for vessels fishing in Area 1 outside the area < 16 miles from shore from Sandy Cove to Hampton.